**General Description**

The MAX9030/MAX9031/MAX9032/MAX9034 single/dual/quad comparators are optimized for single-supply applications from +2.5V to +5.5V but can also be operated from dual supplies. These comparators have a 188ns propagation delay and consume 35µA of supply current per comparator over the -40°C to +125°C operating temperature range. The combination of low-power, single-supply operation down to +2.5V, and ultra-small footprint makes these devices ideal for portable applications.

The MAX9030 is a low-cost single comparator with shutdown. The MAX9031, MAX9032, and MAX9034 are low-cost single, dual, and quad comparators without shutdown, respectively. The comparators’ 4mV of built-in hysteresis provides noise immunity and prevents oscillations even with a slow-moving input signal. The input common-mode range extends from the negative supply to within 1.1V of the positive supply. The design of the comparator output stage substantially reduces switching current during output transitions, virtually eliminating power-supply glitches.

The MAX9030 single comparator with shutdown is available in the space-saving 6-pin SC70 and SOT23 packages. The MAX9031 single comparator is available in tiny 5-pin SC70 and SOT23 packages. The MAX9032 dual comparator is available in 8-pin SOT23 and µMAX® packages, and the MAX9034 quad comparator is available in a 14-pin TSSOP package.

**Features**

- Low-Cost Solution Available in Space-Saving SC70 Packages (MAX9030/MAX9031)
- +2.5 to +5.5V Single-Supply Voltage Range
- Comparator Output Swings Rail-to-Rail
- Internal 4mV Comparator Hysteresis
- 188ns Propagation Delay
- Low 35µA Supply Current
- No Phase Reversal for Overdriven Inputs
- Space-Saving Packages
  - 5-Pin SC70 (MAX9031)
  - 6-Pin SC70 (MAX9030)
  - 8-Pin SOT23 (MAX9032)
  - 14-Pin TSSOP (MAX9034)

**Applications**

- Battery-Powered
- Portable Systems
- Mobile Communications
- Sensor Signal Detection
- Photodiode Preamps
- Digital Line Receivers
- Keyless Entry Systems
- Threshold Detectors/Discriminators

**Typical Application Circuit** appears at end of data sheet.

**Ordering Information**

<table>
<thead>
<tr>
<th>PART</th>
<th>TEMP. RANGE</th>
<th>PIN-PACKAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAX9030AXT+T</td>
<td>-40°C to +125°C</td>
<td>6 SC70</td>
</tr>
<tr>
<td>MAX9030AUT+T</td>
<td>-40°C to +125°C</td>
<td>6 SOT23</td>
</tr>
<tr>
<td>MAX9031AXK+T</td>
<td>-40°C to +125°C</td>
<td>5 SC70</td>
</tr>
<tr>
<td>MAX9031AUK+T</td>
<td>-40°C to +125°C</td>
<td>5 SOT23</td>
</tr>
<tr>
<td>MAX9032AKA+T</td>
<td>-40°C to +125°C</td>
<td>8 SOT23</td>
</tr>
<tr>
<td>MAX9032AUA+</td>
<td>-40°C to +125°C</td>
<td>8 µMAX</td>
</tr>
<tr>
<td>MAX9032ASA+</td>
<td>-40°C to +125°C</td>
<td>8 SO</td>
</tr>
<tr>
<td>MAX9032ASA/V+</td>
<td>-40°C to +125°C</td>
<td>8 SO</td>
</tr>
<tr>
<td>MAX9034AUD+</td>
<td>-40°C to +125°C</td>
<td>14 TSSOP</td>
</tr>
<tr>
<td>MAX9034ASD+</td>
<td>-40°C to +125°C</td>
<td>14 SO</td>
</tr>
</tbody>
</table>

+ Denotes a lead-free(Pb)/RoHS-compliant package.  
T = Tape and reel.  
/V denotes an automotive qualified package.

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For pricing, delivery, and ordering information, please contact Maxim Direct at 1-888-629-4642, or visit Maxim’s website at www.maximintegrated.com.
ABSOLUTE MAXIMUM RATINGS

Supply Voltage (VDD to VSS) .............................................. -0.3V to +6V
Voltage Inputs (IN+, IN- to VSS) ...................... -0.3V to (VDD + 0.3V)
Differential Input Voltage (IN+ to IN-) ...................... +6.6V
Output Short-Circuit Duration ................................ 2s to Either VDD or VSS
Continuous Power Dissipation (TA = +70°C) ............
5-Pin SC70 (derate 3.1mW/°C above +70°C)......... 247mW
5-Pin SOT23 (derate 7.1mW/°C above +70°C) ....... 571mW
6-Pin SC70 (derate 3.1mW/°C above +70°C) .......... 245mW
6-Pin SOT23 (derate 8.7mW/°C above +70°C) ....... 696mW
8-Pin SOT23 (derate 9.1mW/°C above +70°C) ........ 727mW
8-Pin μMAX (derate 4.5mW/°C above +70°C) ........ 362mW
8-Pin SO (derate 5.88mW/°C above +70°C) ........... 471mW
14-Pin TSSOP (derate 9.1mW/°C above +70°C) ....... 727mW
14-Pin SO (derate 8.33mW/°C above +70°C) ........... 667mW

Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(VDD = +5V, VSS = 0, VCM = 0, VSHDN = +5V (Note 1), TA = -40°C to +125°C, unless otherwise noted. Typical values are at TA = +25°C.) (Note 2)
### ELECTRICAL CHARACTERISTICS (continued)

(VDD = +5V, VSS = 0, VCM = 0, VSHDN = +5V (Note 1), TA = -40°C to +125°C, unless otherwise noted. Typical values are at TA = +25°C.) (Note 2)

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNITS</th>
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</thead>
<tbody>
<tr>
<td>Output Voltage-Swing</td>
<td>VOL, VOH</td>
<td>VOH = VDD - VOUT, (VIN+ - VIN-) ≥ 20mV</td>
<td>ISOURCE = 10µA</td>
<td>2</td>
<td></td>
<td>mV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>VOH = VOUT - VSS, (VIN- - VIN+) ≥ 20mV</td>
<td>ISINK = 10µA</td>
<td>2</td>
<td></td>
<td>mV</td>
</tr>
<tr>
<td>Output Short-Circuit Current</td>
<td>ISC</td>
<td>ISOURCE = ISINK = 4mA</td>
<td>45</td>
<td></td>
<td></td>
<td>mA</td>
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<tr>
<td>Shutdown Mode Output Leakage</td>
<td></td>
<td>VSHDN ≤ (0.3 × VDD), VOUT = 0 to VDD</td>
<td>±0.01</td>
<td>±3.5</td>
<td>µA</td>
<td></td>
</tr>
<tr>
<td>Propagation Delay</td>
<td>tPD+, tPD-</td>
<td>RL = 10kΩ, CL = 15pF (Note 5)</td>
<td>VOD = 10mV</td>
<td>228</td>
<td></td>
<td>ns</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>VOD = 100mV</td>
<td>188</td>
<td></td>
<td></td>
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<tr>
<td>Rise/Fall-Time</td>
<td>tr, tf</td>
<td>VDD = +5V, RL = 10kΩ, CL = 15pF (Note 6)</td>
<td>20</td>
<td></td>
<td></td>
<td>ns</td>
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<tr>
<td>Shutdown Delay Time ON/OFF</td>
<td></td>
<td>(Note 1)</td>
<td>40</td>
<td></td>
<td></td>
<td>ns</td>
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<tr>
<td>Shutdown Delay Time OFF/ON</td>
<td></td>
<td>(Note 1)</td>
<td>400</td>
<td></td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>Power-On Time</td>
<td></td>
<td>RL = 10kΩ, CL = 15pF</td>
<td>200</td>
<td></td>
<td></td>
<td>ns</td>
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<tr>
<td>Maximum Capacitive Load</td>
<td>CL</td>
<td>No sustained oscillations</td>
<td>150</td>
<td></td>
<td></td>
<td>pF</td>
</tr>
</tbody>
</table>

**Note 1:** MAX9030 only.
**Note 2:** All devices are production tested at +25°C. All temperature limits are guaranteed by design.
**Note 3:** Comparator Input Offset is defined as the center of the hysteresis zone.
**Note 4:** Hysteresis is defined as the difference of the trip points required to change comparator output states.
**Note 5:** VOD is the overdrive that is beyond the offset and hysteresis-determined trip points.
**Note 6:** Rise and fall times are measured between 10% and 90% at OUT.

### Typical Operating Characteristics

(VDD = +5V, VSS = 0, VCM = 0, RL = 10kΩ, CL = 15pF, VOD = 100mV, TA = +25°C, unless otherwise noted.)
Typical Operating Characteristics (continued)

(VDD = +5V, VSS = 0, VCM = 0, RL = 10kΩ, CL = 15pF, VOD = 100mV, TA = +25°C, unless otherwise noted.)
MAX9030/MAX9031/MAX9032/MAX9034
Low-Cost, Ultra-Small, Single/Dual/Quad Single-Supply Comparators

Typical Operating Characteristics (continued)

(VDD = +5V, VSS = 0, VCM = 0, RL = 10kΩ, CL = 15pF, VOD = 100mV, TA = +25°C, unless otherwise noted.)

PROPAGATION DELAY

OUTPUT SWITCHING CURRENT, RISING

OUTPUT SWITCHING CURRENT, FALLING

SINUSOID 1MHz RESPONSE AT 1.25MHz
VDD = 100mV

SINUSOID 1MHz RESPONSE AT 1.25MHz
VDD = 10mV

POWER-UP DELAY

Maxim Integrated
**Detailed Description**

The MAX9030/MAX9031/MAX9032/MAX9034 are single/dual/quad low-cost comparators. They have an operating supply voltage from +2.5V to +5.5V when operating from a single supply and from ±1.25V to ±2.75V when operating from dual power supplies, and consume only 35µA. Their common-mode input voltage range extends from the negative supply to within 1.1V of the positive supply. Internal hysteresis ensures clean output switching, even with slow-moving input signals.

**Shutdown Mode**

The MAX9030 comparator comes with a power-saving shutdown mode. When in shutdown, the supply current drops from a typical 35µA to 0.05µA, and the outputs become high impedance. SHDN has a high input impedance and typically draws 0.1µA when connected to VSS or VDD. A maximum logic low voltage of 0.3V × VDD applied to SHDN places the device in the shutdown mode. A minimum logic high voltage of 0.7V × VDD applied to SHDN will enable normal operation. To disable shutdown, connect SHDN to VDD.

**Applications Information**

**Adding Hysteresis**

Hysteresis extends the comparator’s noise margin by increasing the upper threshold and decreasing the lower threshold. A voltage-divider from the output of the comparator sets the trip voltage. Therefore, the trip voltage is related to the output voltage.

These comparators have 4mV internal hysteresis. Additional hysteresis can be generated with two resistors using positive feedback (Figure 1). Use the following procedure to calculate resistor values:
Low-Cost, Ultra-Small, Single/Dual/Quad Single-Supply Comparators

1) Find the trip points of the comparator using these formulas:

\[ V_{TH} = V_{REF} + \left(\frac{(V_{DD} - V_{REF})R_2}{R_1 + R_2}\right) \]
\[ V_{TL} = V_{REF}\left(1 - \frac{R_2}{R_1 + R_2}\right) \]

where \( V_{TH} \) is the threshold voltage at which the comparator switches its output from high to low as \( V_{IN} \) rises above the trip point. \( V_{TL} \) is the threshold voltage at which the comparator switches its output from low to high as \( V_{IN} \) drops below the trip point.

2) The hysteresis band will be:

\[ V_{HYS} = V_{TH} - V_{TL} = V_{DD}\left(\frac{R_2}{R_1 + R_2}\right) \]

3) In this example, let \( V_{DD} = +5V \) and \( V_{REF} = +2.5V \).

\[ V_{TH} = 2.5V + 2.5\left(\frac{R_2}{R_1 + R_2}\right)V \]

and

\[ V_{TL} = 2.5\left[1 - \left(\frac{R_2}{R_1 + R_2}\right)\right] \]

4) Select \( R_2 \). In this example, we will choose 1kΩ.

5) Select \( V_{HYS} \). In this example, we will choose 50mV.

6) Solve for \( R_1 \).

\[ V_{HYS} = V_{DD}\left(\frac{R_2}{R_1 + R_2}\right) \]
\[ 0.050V = 5\left(\frac{1000\Omega}{R_1 + 1000\Omega}\right)V \]

where \( R_1 = 100k\Omega \), \( V_{TH} = 2.525V \), and \( V_{TL} = 2.475V \).

The above-described design procedure assumes rail-to-rail output swing. If the output is significantly loaded, the results should be corrected.

**Board Layout and Bypassing**

Use 100nF bypass as a starting point. Minimize signal trace lengths to reduce stray capacitance. Minimize the capacitive coupling between IN- and OUT. For slow-moving input signals (rise-time > 1ms), use a 1nF capacitor between IN+ and IN-.

**Biasing for Data Recovery**

Digital data is often embedded into a bandwidth and amplitude-limited analog path. Recovering the data can be difficult. Figure 2 compares the input signal to a time-averaged version of itself. This self-biases the threshold to the average input voltage for optimal noise margin. Even severe phase distortion is eliminated from the digital output signal. Be sure to choose \( R_1 \) and \( C_1 \) so that:

\[ f_{CAR} \gg \frac{1}{(2\pi R_1 C_1)} \]

where \( f_{CAR} \) is the fundamental carrier frequency of the digital data stream.
MAX9030/MAX9031/MAX9032/MAX9034
Low-Cost, Ultra-Small, Single/Dual/Quad Single-Supply Comparators

Typical Application Circuit

Package Information
For the latest package outline information and land patterns (footprints), go to www.maximintegrated.com/packages. Note that a “+”, “#”, or “-” in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

<table>
<thead>
<tr>
<th>PACKAGE TYPE</th>
<th>PACKAGE CODE</th>
<th>OUTLINE NO.</th>
<th>LAND PATTERN NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 SC70</td>
<td>X5+1</td>
<td>21-0076</td>
<td>90-0188</td>
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<tr>
<td>6 SC70</td>
<td>X6SN+1</td>
<td>21-0077</td>
<td>90-0189</td>
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<tr>
<td>5 SOT23</td>
<td>U5+1</td>
<td>21-0057</td>
<td>90-0174</td>
</tr>
<tr>
<td>6 SOT23</td>
<td>U6SN+1</td>
<td>21-0058</td>
<td>90-0175</td>
</tr>
<tr>
<td>8 SOT23</td>
<td>K8+5</td>
<td>21-0078</td>
<td>90-0176</td>
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<tr>
<td>8 SO</td>
<td>S8+2</td>
<td>21-0262</td>
<td>90-0096</td>
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<tr>
<td>14 SO</td>
<td>S14+1</td>
<td>21-0041</td>
<td>90-0112</td>
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<tr>
<td>8 µMAX</td>
<td>U8+1</td>
<td>21-0036</td>
<td>90-0092</td>
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<tr>
<td>14 TSSOP</td>
<td>U14+1</td>
<td>21-0066</td>
<td>90-0113</td>
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## Revision History

<table>
<thead>
<tr>
<th>REVISION NUMBER</th>
<th>REVISION DATE</th>
<th>DESCRIPTION</th>
<th>PAGES CHANGED</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10/00</td>
<td>Initial release</td>
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</tr>
<tr>
<td>1</td>
<td>5/10</td>
<td>Removed future product reference and added lead-free parts</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>8/12</td>
<td>Added MAX9032ASA/V+ to data sheet</td>
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</table>

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